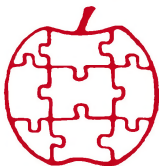


# Apple

\$1.80



# Assembly Line

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Volume 6 -- Issue 10

July, 1986

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## 65816 Books

65816/65802 Assembly Language Programming is here! We have Michael Fischer's book in stock and have filled all the back orders for the first substantial book on programming the 658xx chips. We can now ship your copy immediately, for only \$18 + shipping, so give us a call.

Simon & Schuster reports that Programming the 65816, by David Eyes, will be ready to ship in about two weeks. This time it sounds believable, so next month you should be reading another notice like the one above. Our thanks to all of you who have been so patiently waiting for this long-delayed title.

## A New Debugger

You may have noticed the ads in a couple of recent issues of AAL for a debugger called Quick Tracy. This program proved to be just the thing Bill needed while working on the UniDisk boot program in this issue. Quick Tracy co-resides with the DOS Version 2.0 S-C Macro Assembler, taking up 2K of memory, and you enter all the debugging commands directly from the assembler. You can single-step or trace through your code and set breakpoints on any register's contents (including PC and Stack) or the state of any status flag. This is a useful utility for only \$35. Contact Eric Trehus at (408) 379-0563.

New ProDOS Program Selector.....Bob Sander-Cederlof

In the November 1985 issue of Apple Assembly Line I printed a complete commented listing of the ProDOS QUIT code. This code resides at \$D100-D3FF inside ProDOS, and is downloaded to \$1000 and executed by the \$65 MLI call.

The BYE command in BASIC.SYSTEM and SCASM.SYSTEM both call ProDOS MLI with call number \$65, and so do many other system programs. For some reason FILER has its own quit code, which operates slightly differently from MLI-\$65, but not really better. No one seems to particularly like MLI-\$65, but they usually learn to live with it. That is, unless they purchase Catalyst, MouseFiler, or one of the other commercially-available ProDOS program selectors.

Not wanting to buy three or four different program selectors until I found one I liked, I decided to try writing my own. It replaces the standard QUIT code inside ProDOS, so that MLI-\$65 downloads and executes my new code. My program first lists all of the on-line volume names, so that you can select a volume. You perform the selection by moving the cursor-bar with the arrow keys, and pressing RETURN. ESCAPE makes the program re-do the list of volume names, in case you want to change diskettes. Once a volume is selected, all of the system (SYS) and directory (DIR) filenames in that volume will be listed. Again, you use the arrow keys and RETURN to select either a system program to be executed, or a sub-directory to display. Just a few quick keystrokes and you are in a new application!

Here is an example of the volume name display:

```
S/D  VOLUME NAME
```

```
3/2  RAM
7/1  HARD1
7/2  HARD2
6/1  UTILITIES
```

```
USE ARROWS AND <RETURN> TO SELECT
USE <ESCAPE> TO TRY AGAIN
```

And here is an example of a filename display:

```
/HARD1
```

```
SYS -- PRODOS
SYS -- SCASM.SYSTEM
SYS -- BASIC.SYSTEM
SYS -- CONVERT
SYS -- UTIL.SYSTEM
DIR -- ASM1
DIR -- ASM2
DIR -- SCI
DIR -- FSE
DIR -- XREF
DIR -- SCWP
DIR -- TIMEMASTER
```

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Cross Assemblers for owners of S-C Macro Assembler....\$32.50 to \$50 each  
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8051, 8085, 1802/4/5, PDP-11, G11650/70, others)

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"Programming the 65816", Eyes.....(\$22.95) \$21 \*  
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```
DIR -- THUNDERCLOCK
DIR -- PHASOR
DIR -- MINTERMS
DIR -- DP18
<<<MORE>>>
```

```
USE ARROWS AND <RETURN> TO SELECT
USE <ESCAPE> TO TRY AGAIN
```

All of the SYS files are listed first, and then all of the DIR files, regardless of the order within the directory. This makes it easier to find the file you are looking for. If there are more than 16 filenames to display, the first 16 will be listed, followed by the word "<<<MORE>>>". When you use the arrow keys to move beyond the bottom of the list, if there are more filenames, the list will scroll up to make room for the next name on the screen. When the top name listed is not the first name in the list, the word "<<<MORE>>>" will be displayed above the list. Actually, it is easier to use than it is to describe.

I have gotten so used to an 80-column display now that I decided to make the menu in that mode. Lines 1425-1430 initialize the 80-column display for an enhanced Apple //e or //c. If you want to use some other configuration, or just like 40-columns better, replace those two lines with the following:

```
1421     JSR $FE93
1422     JSR $FE89
1423     STA $C00C
1424     STA $C00F
1425     STA $C000
1426 .2 JSR HOME
```

The six lines above make QUITTER a little too long to fit in three pages, so you need to make room for it somehow. I suggest putting the variables from lines 4870-4950 into page zero, say at \$06-\$0E. This will make the code assemble shorter, so it still fits between \$D100 and \$D3FF inside ProDOS.

An alternative is to make a further modification to ProDOS. The subroutine which downloads the QUIT code is at \$FCE5-FD3A inside ProDOS. It is very inefficient, so there is ample room for adding features. However, by merely changing the LDX #3 at \$FD06 to LDX #4, you can make it download four pages instead of three. When you BLOAD PRODOS at \$2000, the LDX #3 is found at \$4C06. Since the QUIT code is at the end of the PRODOS file, you can write a longer QUIT program if you wish. You also need to change the \$03 at \$2233 to \$04, so that the boot code will install QUIT where it belongs.

### Walking through the New QUITTER

The comments in lines 1010-1090 explain how to install the new QUITTER inside the PRODOS system file. Just in case there is an error, I recommend you try this first on a disk you can

# New Debugging Program For S-C Macro Assembler Users

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- Has 13 independent conditional breakpoints that are easily set and maintained.
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- Can automatically output to your printer only the information needed for debugging, or all available information if specified.
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afford to lose. It all works here, but there's many a slip  
'twixt the cup and the lip!

Line 1320 switches on the motherboard ROM code, so that we can use Apple monitor routines. Lines 1330-1410 clear out the memory bitmap in the ProDOS System Global Page. We have to do that so we can load another system file. Once the bitmap has been cleared, it is not safe to try to return to whatever system program was operating before QUITTER was entered. Anyway, the RESET vector has already been pointed at QUITTER, so it is pretty difficult to get out of QUITTER. If you wish, you could add a feature that allows aborting the QUIT call, but be aware that the memory bitmap will have been messed up.

Lines 1420-1590 display a list of all the volumes currently on-line, and allow you to move the cursor bar up and down the list. The subroutine DISPLAY.VOLUMES lists the volume names, displaying the one under the cursor in inverse mode. The subroutine GET.KEY accepts the four arrow keys, RETURN, and ESCAPE. The left and up arrows move the cursor bar up, while the right and down arrows move the cursor bar down. GET.KEY is a little complicated, since it also handles windowing for long lists of filenames.

The subroutine READ.THE.FILE, called from line 1610, reads in an entire volume directory or sub-directory. ProDOS has the built-in ability to read directories just as though they were regular files, so READ.THE.FILE is pretty simple: it merely OPENS the file, READS it, and CLOSES it. Lines 2030-2150 perform the additional task of appending the current volume or filename to the previous prefix.

Lines 1640-1710 clear the screen and display the pathname of the selected directory, in preparation for display a file menu. Lines 1720-1800 collect a list of pointers to all of the SYS and DIR files in the directory, using the SCAN.DIRECTORY subroutine. SCAN.DIRECTORY appends a pointer to a list of pointers in DIRBUF for each file it finds of the specified type.

Lines 1810-1900 display the SYS and DIR files found in the directory. If there are more than 16 files, the word "<<<MORE>>>" will be displayed after the 16th name. Moving the cursor bar down will scroll the list up, so that you can see the rest of the filenames. If you press ESCAPE or RESET, it all starts over collecting volume names. If you press RETURN when the cursor bar is on a DIR file, the directory name will be added to the current prefix and a new filename list will appear.

If you press RETURN when the cursor bar is on a SYS file, lines 1950-1990 will load the system file and start it running. Lines 1950-1960 set the system prefix to the directory the system file is in. Lines 1970-1980 read the file into RAM starting at \$2000, and if there are no errors we blast-off with a JMP \$2000. If there ARE errors, the program just starts over.

```

1000 *SAVE NEW.QUIT.CODE
1010 *-----
1020 *      Installation:
1030 *      1.  BLOAD PRODOS,TSYS,A$2000
1040 *      2.  BLOAD B.NEW.QUITTER,A$5700
1050 *      3.  BSAVE PRODOS,TSYS,A$2000,L$3A00
1060 *      Location:
1070 *      In PRODOS file:      $5700-59FF
1080 *      In ProDOS image:    $D100-D3FF
1090 *      For execution:      $1000-12FF
1100 *-----
1110 *      Code which downloads the QUIT code resides at
1120 *      $FCE5-FD3A. This is loaded from $4BE5-4C3A.
1130 *-----
00- 1140 BPNTR .EQ $00,01
02- 1150 SPNTR .EQ $02,03
04- 1160 DPNTR .EQ $04,05
25- 1170 CV .EQ $25
32- 1180 INVFLG .EQ $32
1190 *-----
FC58- 1200 HOME .EQ $FC58
FC9C- 1210 CLREQL .EQ $FC9C
FDED- 1220 COUT .EQ $FDED
FD8E- 1230 CROUT .EQ $FD8E
1240 *-----
BF00- 1250 MLI .EQ $BF00
BF58- 1260 BITMAP .EQ $BF58
1270 *-----
1000- 1280 .OR $1000
1290 .TF B.NEW.QUITTER
1300 *-----
1310 QUITTER
1000- AD 82 CO 1320 LDA $C082 MOTHERBOARD ROMS
1003- A2 16 1330 LDX #$16
1005- A9 00 1340 LDA #0 PREPARE VIRGIN BITMAP
1007- 9D 58 BF 1350 .1 STA BITMAP,X
100A- CA 1360 DEX
100B- D0 FA 1370 BNE .1
100D- E8 1380 INX X=1, LOCKOUT $BF00 PAGE
100E- 8E 6F BF 1390 STX BITMAP+$17
1011- A9 CF 1400 LDA #$CF
1013- 8D 58 BF 1410 STA BITMAP
1420 *---LIST VOLUME NAMES-----
1016- A9 99 1425 .2 LDA #$99 CTRL-Y
1018- 20 00 C3 1430 JSR $C300 SET I/O HOOKS, 80-COL MODE, CLEAR SCREEN
101B- A0 00 1440 LDY #Q.SDV
101D- 20 8A 12 1450 JSR MSG
1020- 20 D7 10 1460 JSR CLOSE.ALL.FILES
1023- 20 00 BF 1470 JSR MLI
1026- C5 37 11 1480 .DA #$C5,ONLINE
1029- A0 00 1490 LDY #0
102B- 8C 42 0E 1500 STY MAX.DIRPNT
102E- 8C 41 0E 1510 STY DIR.START
1031- 8C 00 0E 1520 STY PATHNAME
1034- 8C 43 0E 1530 .3 STY SEL.LINE
1037- 20 4C 11 1540 JSR DISPLAY.VOLUMES
103A- A0 11 1550 LDY #Q.VHELP
103C- 20 8A 12 1560 JSR MSG
103F- 20 C0 11 1570 JSR GET.KEY
1042- 90 F0 1580 BCC .3 ...ARROW KEYS
1044- D0 D0 1590 BNE .2 ...ESCAPE KEY
1600 *---READ DIRECTORY-----
1046- 20 9F 10 1610 .4 JSR READ.THE.FILE
1049- B0 51 1620 BCS .7
1630 *---PRINT PATHNAME-----
104B- 20 58 FC 1640 JSR HOME
104E- A0 00 1650 LDY #0
1050- B9 01 0E 1660 .5 LDA PATHNAME+1,Y
1053- 09 80 1670 ORA #$80
1055- 20 ED FD 1680 JSR COUT
1058- C8 1690 INY
1059- CC 00 0E 1700 CPY PATHNAME
105C- 90 F2 1710 BCC .5
1720 *---COLLECT FILENAMES-----
105E- A2 00 1730 LDX #0
1060- A9 FF 1740 LDA #$FF FIRST JUST "SYS" FILES

```

	IN 101 SPRINT	UNIT IMPACT	LOW LEVEL REASON	NO COURSE ACTION	NO INVEST	UNIT IMPACT IN 101	IN 101 COURSE ACTION	IN 101 COURSE ACTION
<b>VIEWMASTER 80</b>								
SI PRTERM	-	-	-	-	-	-	-	-
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COMBINION	-	-	-	-	-	-	-	-
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```

118E- 85 00 3220 STA BPNTN
1190- 90 02 3230 BCC .4
1192- E6 01 3240 INC BPNTN+1
1194- CE 46 OE 3250 .4 DEC LENGTH ANY MORE LEFT?
1197- D0 BE 3260 BNE .1 ...YES
1199- 60 3270 RTS
3280 #-----
3290 PRINT.BPNTN.NAME
119A- A0 00 3300 LDY #0
119C- B1 00 3310 LDA (BPNTN),Y GET NAME LENGTH
119E- 29 OF 3320 AND #$0F
11A0- AA 3330 TAX
11A1- C8 3340 .1 INY PRINT THE VOLUME NAME
11A2- B1 00 3350 LDA (BPNTN),Y
11A4- 09 80 3360 ORA #$80
11A6- 20 ED FD 3370 JSR COUT
11A9- CA 3380 DEX
11AA- 10 F5 3390 BPL .1
3400 #-----
11AC- A9 A0 3410 .2 LDA #" " PRINT TRAILING BLANKS
11AE- 20 ED FD 3420 JSR COUT
11B1- C8 3430 INY
11B2- C0 10 3440 CPY #16
11B4- 90 F6 3450 BCC .2
11B6- A9 FF 3460 LDA #$FF NORMAL MODE NOW
11B8- 85 32 3470 STA INVFLG
11BA- EE 44 OE 3480 INC MAX.LINE COUNT THE LINE
11BD- 4C 8E FD 3490 JMP CROUT
3500 #-----
3510 GET.KEY
11C0- AD 00 CO 3520 .1 LDA $C000 READ KEY FROM KEYBOARD
11C3- 10 FB 3530 BPL .1
11C5- 8D 10 CO 3540 STA $C010 CLEAR THE STROBE
11C8- C9 8D 3550 CMP #$8D
11CA- F0 16 3560 BEQ .2 <RETURN>
11CC- C9 88 3570 CMP #$88 <--
11CE- F0 13 3580 BEQ .3
11D0- C9 95 3590 CMP #$95 -->
11D2- F0 26 3600 BEQ .7
11D4- C9 8A 3610 CMP #$8A DOWN ARROW
11D6- F0 22 3620 BEQ .7
11D8- C9 8B 3630 CMP #$8B UP ARROW
11DA- F0 07 3640 BEQ .3
11DC- C9 9B 3650 CMP #$9B ESCAPE
11DE- D0 E0 3660 BNE .1 GET ANOTHER CHARACTER
11E0- A9 9B 3670 LDA #$9B ...SET .NE.
11E2- 60 3680 RTS
3690 #---<UP OR LEFT ARROW>-----
11E3- AC 43 OE 3700 .3 LDY SEL.LINE CURRENT BRIGHT LINE
11E6- D0 OF 3710 BNE .6 ...NOT TOP LINE
11E8- AC 41 OE 3720 LDY DIR.START ARE WE DISPLAYING THE FIRST ONE?
11EB- F0 07 3730 BEQ .5 ...YES
11ED- CE 41 OE 3740 DEC DIR.START ...NO, MOVE TOWARD FIRST LINE
11F0- A0 00 3750 .4 LDY #0 MAKE FIRST LINE BRIGHT
11F2- 18 3760 CLC
11F3- 60 3770 RTS
11F4- AC 44 OE 3780 .5 LDY MAX.LINE MAKE LAST LINE BRIGHT
11F7- 88 3790 .6 DEY
11F8- 18 3800 CLC
11F9- 60 3810 RTS
3820 #---<DOWN OR RIGHT ARROW>-----
11FA- AC 43 OE 3830 .7 LDY SEL.LINE CURRENT BRIGHT LINE
11FD- C8 3840 INY MOVE TOWARD LAST LINE
11FE- CC 44 OE 3850 CPY MAX.LINE BEYOND END OF SCREEN?
1201- 90 13 3860 BCC .8 ...NO
1203- AD 42 OE 3870 LDA MAX.DIRPNT ...YES. CHECK IF SHOWING LAST LINE
1206- E9 11 3880 SBC #17
1208- 90 E6 3890 BCC .4 ...YES
120A- CD 41 OE 3900 CMP DIR.START
120D- 90 E1 3910 BCC .4 ...YES
120F- EE 41 OE 3920 INC DIR.START ...NO, MOVE TOWARD LAST LINE
1212- AC 43 OE 3930 LDY SEL.LINE
1215- 18 3940 CLC
1216- 60 3950 .8 RTS
3960 #-----
3970 DISPLAY.FILES
1217- 20 61 12 3980 JSR SETUP.DISPLAY.LOOP

```

```

121A- AD 41 OE 3990      LDA DIR.START
121D- 8D 40 OE 4000      STA DIR.INDEX
1220- 20 54 12 4010      JSR CLEAR.LINE.OR.PRINT.MORE.MSG
4020 *-----
1223- AE 40 OE 4030      .1   LDX DIR.INDEX
1226- BC 00 OD 4040      LDY DIRBUF+256,X
1229- FO 23      4050      BEQ .4      ...END OF LIST
122B- 84 01      4060      STY BPNT+1
122D- BD 00 OC 4070      LDA DIRBUF,X
1230- 85 00      4080      STA BPNT
1232- 20 71 12 4090      JSR CHECK.FOR.SEL.LINE
4100 *-----
1235- A0 10      4110      .2   LDY #10
1237- B1 00      4120      LDA (BPNT),Y
1239- 30 03      4130      BMI .3      ...SYS FILE
123B- A0 57      4140      LDY #Q.DIR
123D- 2C      4150      .HS 2C
123E- A0 4F      4160      .3   LDY #Q.SYS
1240- 20 8A 12 4170      JSR MSG
1243- 20 9A 11 4180      JSR PRINT.BPNT.NAME
4190 *-----
1246- EE 40 OE 4200      INC DIR.INDEX
1249- CE 46 OE 4210      DEC LENGTH
124C- D0 D5      4220      BNE .1
124E- AD 40 OE 4230      .4   LDA DIR.INDEX
1251- CD 42 OE 4240      CMP MAX.DIRPNT
4250 *-----
1254- FO 05      4260      CLEAR.LINE.OR.PRINT.MORE.MSG
1256- A0 5F      4270      BEQ .1      CLEAR LINE
1258- 4C 8A 12 4280      LDY #Q.MORE
125B- 20 9C FC 4290      JMP MSG
125E- 4C 8E FD 4300      .1   JSR CLREQ
4310      JMP CROUT
4320 *-----
1261- A9 10      4330      SETUP.DISPLAY.LOOP
1263- 8D 46 OE 4340      LDA #16      MAX 16 LINES IN LIST
1266- A0 00      4350      STA LENGTH
1268- 8C 44 OE 4360      LDY #0
126B- C8      4370      STY MAX.LINE
126C- 84 25      4380      INY      SAME AS VTAB 3, HTAB 1
126E- 4C 8E FD 4390      STY CV
4400      JMP CROUT
4410 *-----
1271- AD 44 OE 4430      CHECK.FOR.SEL.LINE
1274- CD 43 OE 4440      LDA MAX.LINE
1277- D0 OC      4450      CMP SEL.LINE      SEE IF CURRENT LINE SHOULD
1279- A5 00      4460      BNE .1      BE INVERSE MODE
127B- 85 02      4470      LDA BPNT      ...NO
127D- A5 01      4480      STA SPNT      ...YES, SO SETUP POINTER
127F- 85 03      4490      LDA BPNT+1
1281- A9 3F      4500      STA SPNT+1
1283- 85 32      4510      LDA #3F      & SET INVERSE MODE
1285- 60      4520      STA INVFLG
4530      RTS
4540 *-----
1286- 20 ED FD 4540      .1   MSG1 JSR COUT
1289- C8      4550      INY
128A- B9 90 12 4560      MSG   LDA QTS,Y
128D- D0 F7      4570      BNE MSG1
128F- 60      4580      RTS
4590 *-----
1290-      4600      QTS      .EQ #
00-      4610      Q.SDV      .EQ #-QTS
1290- D3 AF C4
1293- A0 A0 D6
1296- CF CC D5
1299- CD C5 A0
129C- CE C1 CD
129F- C5      4620      .AS -"S/D VOLUME NAME"
12A0- 00      4630      .HS 00
11-      4640      Q.VHELP .EQ #-QTS
12A1- 8D      4650      .HS 8D
12A2- D5 D3 C5
12A5- A0 C1 D2
12A8- D2 CF D7
12AB- D3 A0 C1
12AE- CE C4 A0

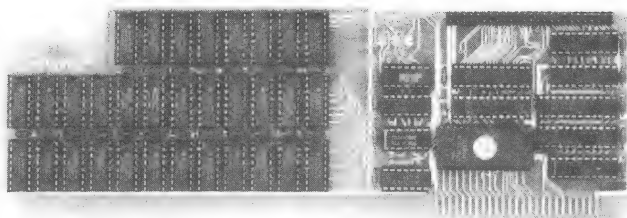
```

# RamFactor™

*All the Performance, Speed, and Software Compatibility of RamWorks™ in a Slot 1 through 7 Card.*

That's right! Now Applied Engineering offers you a choice. While RamWorks is the clear winner for the auxiliary slot in a IIe, RamFactor is the standard for slots 1 through 7. Now anyone with an Apple II+, Franklin, or Apple IIe preferring to use slots 1 through 7 can now enjoy the speed and performance that until now was only available with RamWorks.

With RamFactor, you'll be able to instantly add another 256K, 512K, or a full 1 meg on the main board and up to 16 meg with additional piggyback card. And since virtually all software is automatically compatible with RamFactor, you'll immediately be able to load programs into RamFactor for instantaneous access to information. You'll also be able to store more data for larger word processing documents, bigger data bases, and expanded spreadsheets.



## Very Compatible

All the leading software is already compatible with RamFactor. Programs like AppleWorks, Pinpoint, BPI, Managing Your Money, Dollars and Sense, SuperCalc 3A, PFS, MouseWrite, MouseDesk, MouseCalc, Sensible Speller, Applewriter IIe, Business Works, ReportWorks, Catalyst 3.0 and more. And RamFactor is fully ProDOS, DOS 3.3, Pascal 1.3 and CP/M compatible. In fact, no other memory card (RamWorks excepted) is more compatible with commercial software.

## AppleWorks Power

There are other slot 1-7 cards that give AppleWorks a larger desktop, but that's the end of their story. But RamFactor is the only slot 1-7 card that increases AppleWorks internal memory limits, increasing the maximum number of lines permitted in the word processor, and RamFactor is the only standard slot card that will automatically load AppleWorks into RAM dramatically increasing speed and eliminating the time required to access the program disk, it will even display the time and date on the AppleWorks screen with any ProDOS clock. RamFactor will automatically segment large files so they can be saved on 5¼", 3½", and hard disks. All this performance is available to anyone with an Apple IIe or II+ with an 80 column card.

RamFactor, no other standard slot card comes close to enhancing AppleWorks so much.

## True 65C816 16 Bit Power

RamFactor has a built-in 65C816 CPU port for direct connection to our IIe 65C816 card for linearly addressing up to 16 meg for the most powerful 16 bit applications (II+ 65C816 card under development.)

## Powerful Program Switcher

With RamFactor, you can organize memory into multiple work areas and switch between them. Each work area can contain different programs and even different operating systems. Now you can switch from one program to another or even switch from AppleWorks to DOS 3.3 to CP/M to Pascal to ProDOS in under a second. And with our Battery back-up option, you can have permanent storage for up to 20 years.

## Quality and Support of the Industry Leader

RamFactor is from Applied Engineering, the largest, most well supported manufacturer of Apple peripherals and the inventor of large RAM cards for the Apple. With our 5 year no hassle warranty and outstanding technical support, you're assured of the most trouble free product you can buy.

## Features:

- Up to 16 meg total memory, 256K to 1 meg on main board. Up to 16 meg with additional memory on piggyback card.
- Fully Apple II Memory Expansion compatible
- Compatible with Apple IIe, II+ and Franklin
- Battery back-up option allows you to turn on your Apple and run your favorite programs in less than 1 second!
- Automatically recognized by ProDOS, DOS 3.3, Pascal and CP/M
- Built-in RamDrive™ software (a true RAM disk not disk caching)
- Systems are directly bootable from RamFactor if desired
- Built-in linear addressing 16 bit co-processor port
- Built-in self diagnostic software
- Automatic expansion with AppleWorks 1.3 or later
- Allows Apple II+ and IIe to run your AppleWorks without buying additional software
- Accelerates AppleWorks
- Displays time and date on the AppleWorks screen with any ProDOS clock
- Fits any I/O slot except slot 3
- Fully socketed and user upgradeable
- Much, much more

RamFactor with 256K	\$239
RamFactor with 512K	\$289
RamFactor with 1 MEG	\$389
RamFactor with 2-16 MEG	CALL
Battery Back-up Option	\$179
65C816 16 Bit Card	\$159

Order RamFactor today... with 15 day money back guarantee and our "no hassle" five year warranty. Call 9 a.m. to 11 p.m., 7 days, or send check or money order to Applied Engineering, MasterCard, Visa and C.O.D. welcome. Texas residents add 5.4% sales tax. Add \$10.00 if outside U.S.A.

**AE Applied Engineering**  
*The Apple enhancement experts.*

(214) 241-6060

P.O. Box 798, Carrollton, TX 75006

```

12B1- BC D2 C5
12B4- D4 D5 D2
12B7- CE BE A0
12BA- D4 CF A0
12BD- D3 C5 CC
12C0- C5 C3 D4 4660 .AS -/USE ARROWS AND <RETURN> TO SELECT/
12C3- 8D 4670 .HS 8D
12C4- D5 D3 C5
12C7- A0 BC C5
12CA- D3 C3 C1
12CD- D0 C5 BE
12D0- A0 D4 CF
12D3- A0 D4 D2
12D6- D9 A0 C1
12D9- C7 C1 C9
12DC- CE 4680 .AS -/USE <ESCAPE> TO TRY AGAIN/
12DD- 8D 4690 .HS 8D
12DE- 00 4700 .HS 00
4F- 4710 Q.SYS .EQ #-QTS
12DF- D3 D9 D3
12E2- A0 AD AD
12E5- A0 4720 .AS -/SYS -- /
12E6- 00 4730 .HS 00
57- 4740 Q.DIR .EQ #-QTS
12E7- C4 C9 D2
12EA- A0 AD AD
12ED- A0 4750 .AS -/DIR -- /
12EE- 00 4760 .HS 00
5F- 4770 Q.MORE .EQ #-QTS
12EF- BC BC BC
12F2- CD CF D2
12F5- C5 BE BE
12F8- BE 4780 .AS -/<<<MORE>>>/
69- 4790 Q.CR .EQ #-QTS
12F9- 8D 00 4800 .HS 8D00
4810 #-----
4820 .DUMMY
4830 .OR $800
0800- 4840 OPNBUF .BS 1024
0C00- 4850 DIRBUF .BS 512
0E00- 4860 PATHNAME .BS 64
0E40- 4870 DIR.INDEX .BS 1
0E41- 4880 DIR.START .BS 1
0E42- 4890 MAX.DIRPNT .BS 1
0E43- 4900 SEL.LINE .BS 1
0E44- 4910 MAX.LINE .BS 1
0E45- 4920 UNIT .BS 1
0E46- 4930 LENGTH .BS 1
0E47- 4940 CURTYP .BS 1
0E48- 4950 CURBLK .BS 1
4960 .ED
4970 #-----
2000- 4980 BUFFER .EQ $2000
2023- 4990 ENTLEN .EQ BUFFER+$23 ENTRY LENGTH
2024- 5000 ENT CNT .EQ BUFFER+$24 # ENTRIES PER BLOCK
5010 #-----

```

## The QUIT-code Installer

As I just mentioned, the code which downloads the QUIT-code from \$D100-D3FF to \$1000-12FF is located at \$FCE5 inside ProDOS 1.1.1. Here is a commented listing of that code.

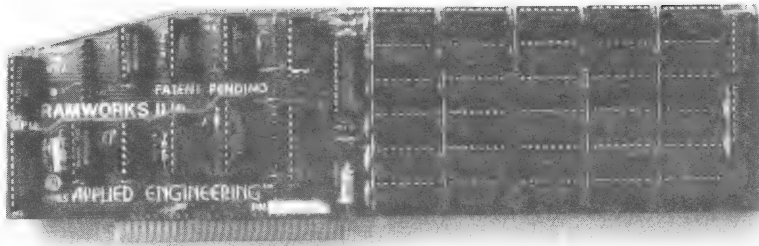
```

1000 *SAVE S.FCE5.FD3A
1010 #-----
1020 .OR $FCE5
1030 .TA $800
1040 DOWNLOAD.QUITTER
FCE5- AD 83 C0 1050 LDA $C083 SWITCH IN CORRECT D000 BANK
FCE8- AD 83 C0 1060 LDA $C083
1070 #-----
FCEB- A5 00 1080 LDA $00 SAVE 00...03 ON STACK
FCED- 48 1090 PHA
FCEE- A5 01 1100 LDA $01
FCF0- 48 1110 PHA
FCF1- A5 02 1120 LDA $02

```

# RamWorks II<sup>®</sup>

*The Best Selling, Most Compatible, Most Recommended, Most Expandable Card Available.*



*64K to 16 MEG! RamWorks II Is Number One.*

It's simple, RamWorks II sells the most because it does the most.

## **The AppleWorks Amplifier.**

While RamWorks II is recognized by all memory intensive programs, NO other expansion card comes close to offering the multitude of enhancements to AppleWorks that RamWorks II does. Naturally, you'd expect RamWorks II to expand the available desktop, after all Applied Engineering was a year ahead of everyone else *including Apple* in offering more than 55K in AppleWorks and we still provide the largest AppleWorks desktops available. But a larger desktop is just part of the story. Just look at all the AppleWorks enhancements that even Apple's own card does not provide and *only* RamWorks II does. With a 256K or larger RamWorks II, all of AppleWorks will automatically load itself into RAM dramatically increasing speed by eliminating all the time required to access the program disk drive. Now switch from word processing to spreadsheet to database at the speed of light with no wear on disk drives.

*Only* RamWorks II eliminates AppleWorks' internal memory limits, increasing the maximum number of records available from 1,350 to over 15,000. *Only* RamWorks II increases the number of lines permitted in the word processing mode from 2,250 to over 15,000. And *only* RamWorks II (256K or larger) offers a built-in printer buffer, so you won't have to wait for your printer to stop before returning to AppleWorks. Ram-

Works II even expands the clipboard. And auto segments large files so they can be saved on two or more disks.

RamWorks II, nothing comes close to enhancing AppleWorks so much.

## **The Most Friendly, Most Compatible Card Available.**

Using RamWorks II couldn't be easier because it's compatible with more off-the-shelf software than any other RAM card. Popular programs like AppleWorks, Pinpoint, Catalyst, MouseDesk, HowardSoft, FlashCalc, The Spread Sheet, Managing Your Money, SuperCalc 3a, and MagiCalc to name a few (and *all* hardware add on's like ProFile and Sider hard disks). RamWorks II is even compatible with software written for Apple cards. But unlike other cards, RamWorks II plugs into the IIe auxiliary slot providing our super sharp 80 column text in a completely integrated system while leaving expansion slots 1 through 7 available for other peripheral cards.

## **Highest Memory Expansion.**

Applied Engineering has always offered the largest memory for the IIe and RamWorks II continues that tradition by expanding to 1 full MEG on the main card using standard RAMs, more than most will ever need (1 meg is about 500 pages of text)...but if you do ever need more, RamWorks II has the widest selection of expander cards available. Additional 512K, 2 MEG, or multiple 16 MEG cards just snap directly onto RamWorks II by plugging into the

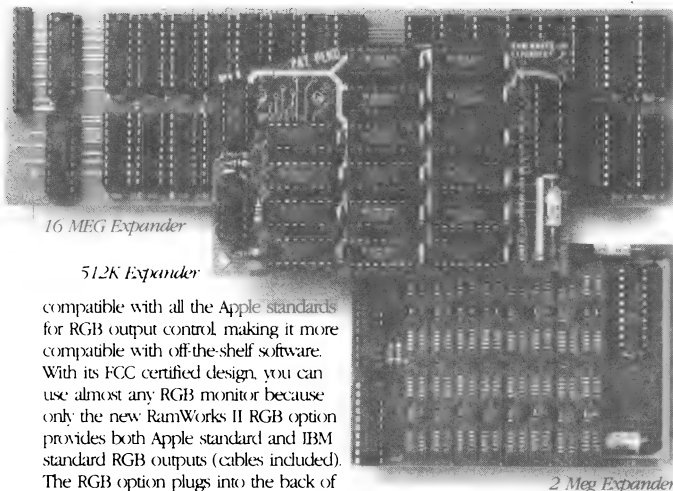
industry's only low profile (no slot 1 interference) fully decoded memory expansion connector. You can also choose non-volatile, power independent expanders allowing permanent storage for over 20 years.

## **It Even Corrects Mistakes.**

If you've got some other RAM card that's not being recognized by your programs, and you want RamWorks II, you're in luck. Because all you have to do is plug the memory chips from your current card into the expansion sockets on RamWorks II to recapture most of your investment!

## **The Ultimate in RGB Color.**

RGB color is an option on RamWorks II and with good reason. Some others combine RGB output with their memory cards, but that's unfair for those who don't need RGB *and* for those that do. Because if you don't need RGB Applied Engineering doesn't make you buy it, but if you want RGB output you're in for a nice surprise because the RamWorks II RGB option offers better color graphics plus a more readable 80 column text (that blows away any composite color monitor). For only \$129 it can be added to RamWorks II, giving you a razor sharp, vivid brilliance that most claim is the best they have ever seen. You'll also appreciate the multiple text colors (others only have green) that come standard. But the RamWorks II RGB option is more than just the ultimate in color output because unlike others, it's fully



16 MEG Expander

512K Expander

compatible with all the Apple standards for RGB output control, making it more compatible with off-the-shelf software. With its FCC certified design, you can use almost any RGB monitor because only the new RamWorks II RGB option provides both Apple standard and IBM standard RGB outputs (cables included). The RGB option plugs into the back of RamWorks II with no slot 1 interference (works on the original RamWorks, too) and remember you can order the RGB option with your RamWorks II or add it on at a later date.

### True 65C816 16 Bit Power.

RamWorks II has a built-in 65C816 CPU port for direct connection to our optional 65C816 card. The only one capable of linearly addressing more than 1 meg of memory for power applications like running the Lotus 1-2-3™ compatible program, VIP Professional. Our 65C816 card does not use another slot but replaces the 65C02 yet maintains full 8 bit compatibility.

### Endorsed by the Experts.

Steve Wozniak, creator of the Apple Computer said "I wanted a memory card for my Apple that was fast, easy to use, and very compatible; so I bought RamWorks." A+ magazine said "Applied Engineering's RamWorks is a boon to those who must use large files with AppleWorks...I like the product so much that I am buying one for my own system." inCider magazine said "RamWorks II is the most powerful auxiliary slot memory card available for your IIe, and I rate it four stars. For my money, Applied Engineering's RamWorks II is king of the hill."

Apple experts everywhere are impressed by RamWorks II's expandability, versatility, ease of use, and the sheer power and speed that it adds to any IIe. With a RamWorks II in your Apple, you'll make IBM PCs and AT's look like slowpokes.

### It's Got It All

- 15 day money back guarantee
- 5 year hassle free warranty insures coverage no matter where you purchase
- Built-in super sharp 80 column display, (with or without RGB)
- Expandable to 1 MEG on main card
- Expandable to 16 meg with expander card, with NO slot 1 interference
- Can use 64K or 256K RAMs
- Powerful linear addressing 16 bit coprocessor port
- Automatic AppleWorks expansion up to 3017K desktop
- Accelerates AppleWorks
- Built-in AppleWorks printer buffer
- The only large RAM card that's 100% compatible with all IIe software

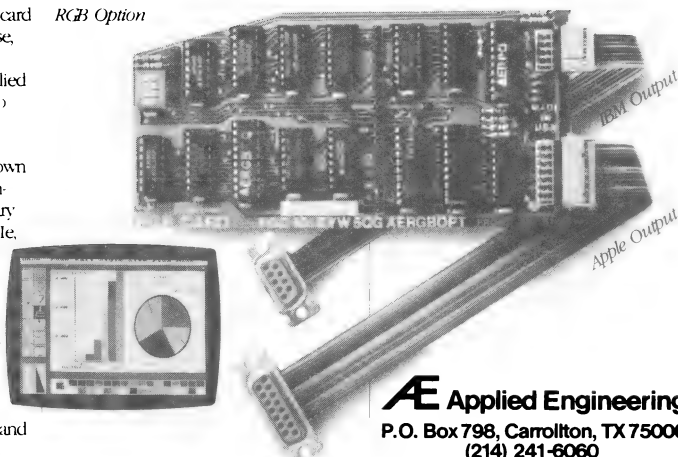
2 Meg Expander

- RamDrive™ the ultimate disk emulation software included free
- Memory is easily partitioned allowing many programs to be in memory at once
- Compatible, RGB option featuring ultra high resolution color graphics and multiple text colors, with cables for both Apple and IBM type monitors
- Built-in self diagnostics software
- Lowest power consumption (patent pending)
- Takes only one slot (auxiliary) even when fully expanded
- Software industry standard
- Advanced Computer Aided Design
- Used by Apple Computer, Steve Wozniak and virtually all software companies
- Displays date and time on the AppleWorks screen with any PRO-DOS compatible clock
- Much, much more!

RamWorks II with 64K	\$179
RamWorks II with 256K	\$219
RamWorks II with 512K	\$269
RamWorks II with 1 MEG	\$369
RamWorks II with 1.5 MEG	\$539
RamWorks II with 3 to 16 MEG	CALL
65C816 16 Bit Card	\$159
RGB Option	\$129
256K Upgrade	\$ 50

RamWorks II. The industry standard for memory expansion of the Apple IIe. ORDER YOUR RamWorks II TODAY. 9 a.m. to 11 p.m. 7 days, or send check or money order to Applied Engineering. MasterCard, Visa and C.O.D. welcome. Texas residents add 5½% sales tax. Add \$10.00 if outside U.S.A.

### RGB Option



**AE Applied Engineering**  
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```

FCF3- 48      1130      PHA
FCF4- A5 03    1140      LDA $03
FCF6- 48      1150      PHA
1160      *---SETUP POINTERS FOR MOVING---
FCF7- A9 10    1170      LDA /$1000      Destination Pointer
FCF9- 85 03    1180      STA $03
FCFB- A9 D1    1190      LDA /$D100      Source Pointer-
FCFD- 85 01    1200      STA $01
FCFF- A9 00    1210      LDA #0
FD01- 85 00    1220      STA $00
FD03- 85 02    1230      STA $02
1240      *-----
FD05- A8      1250      TAY      Y=0
FD06- A2 03    1260      LDX #3      Move 3 Pages
FD08- 88      1270      DEY      .1
FD09- B1 00    1280      LDA ($00),Y
FD0B- 91 02    1290      STA ($02),Y
FD0D- 98      1300      TYA
FD0E- D0 F8    1310      BNE .1      ...More in same page
FD10- E6 01    1320      INC $01
FD12- E6 03    1330      INC $03      Advance to next pages
FD14- CA      1340      DEX      Count the page
FD15- D0 F1    1350      BNE .1      ...Copy another page
1360      *---Restore $03...$00-----
FD17- 68      1370      PLA
FD18- 85 03    1380      STA $03
FD1A- 68      1390      PLA
FD1B- 85 02    1400      STA $02
FD1D- 68      1410      PLA
FD1E- 85 01    1420      STA $01
FD20- 68      1430      PLA
FD21- 85 00    1440      STA $00
1450      *-----
FD23- AD 8B C0 1460      LDA $C08B      Select normal D000 bank
FD26- AD 8B C0 1470      LDA $C08B
1480      *---Set up RESET Vector-----
FD29- A9 00    1490      LDA #$1000      Lo-byte
FD2B- 8D F2 03 1500      STA $3F2
FD2E- A9 10    1510      LDA /$1000      Hi-byte
FD30- 8D F3 03 1520      STA $3F3
FD33- 49 A5    1530      EOR #$A5      Power-up byte
FD35- 8D F4 03 1540      STA $3F4
1550      *-----
FD38- 4C 00 10 1560      JMP $1000
1570      *-----

```

The program above can be written in a lot less space, as follows:

```

1580      *-----
1590      .OR $FCE5
1600      .TA $900
1610      SC.DOWNLOAD,QUITTER
1620      LDA $C083      Select D000 bank
1630      *-----
FCE5- AD 83 C0 1640
1650      LDY #0
FCE8- A0 00    1660      LDA $D100,Y      .1
FCEA- B9 00 D1 1670      STA $1000,Y
FCED- 99 00 10 1680      LDA $D200,Y
FCF0- B9 00 D2 1690      STA $1100,Y
FCF3- 99 00 11 1700      LDA $D300,Y
FCF6- B9 00 D3 1710      STA $1200,Y
FCF9- 99 00 12 1720      INY
FCFC- C8      1730      BNE .1
FCFD- D0 EB    1740      *-----
FCFF- AD 8B C0 1750      LDA $C08B      Select normal D000 bank
1760      *---Set up RESET Vector-----
FD02- 8C F2 03 1770      STY $3F2      RESET Vector Lo-byte
FD05- A9 10    1780      LDA /$1000      Hi-byte
FD07- 8D F3 03 1790      STA $3F3
FD0A- 49 A5    1800      EOR #$A5      Power-up byte
FD0C- 8D F4 03 1810      STA $3F4
1820      *-----
FD0F- 4C 00 10 1830      JMP $1000
1840      *-----

```

A customer called up the other day to order the DP18 Source Code package, but he wanted it only if it ran under ProDOS. (That's 18-digit Binary Coded Decimal arithmetic for Applesoft.) Well, we hadn't tried to move it over before, but it didn't sound like too much of a problem, so I gave it a shot. It did turn out to be quite easy.

I first tried simply CONVERTing all the files over, including the binary object code, and RUNning the example programs. That almost worked! The DP18 arithmetic all operated just right, but the scheme of moving the Applesoft program up and BLOADing DP18 at \$803 ran into a little trouble. The forward pointers in each line of the program weren't set up properly. Bob then pointed out to me that it's very easy to install a program between BASIC.SYSTEM and the buffers, so that might be the way to go in this situation. All it took was a little arithmetic to figure out that DP18 needs \$1C pages and should therefore have an origin of \$7E00. The .OR directive was the only line inside DP18 that I had to change!

After that I needed only two more things: a short machine language program to get the buffer from BI, issue the BLOAD command, and set the ampersand vector; and a one-line Applesoft routine that checks the vector to find out if DP18 is already installed and call the loader if not.

Here's the Applesoft routine:

```
10 IF PEEK (1014) + 256 * PEEK (1015) < > 32563 THEN
PRINT CHR$ (4) "BRUN INSTALL.DP18"
```

And here's all there is to the loader:

```

1000 #SAVE S.INSTALL.DP18
1010 #-----
0200- 1020 BUFFER .EQ $200
1030
03F6- 1040 AMPERSAND .EQ $3F6
1050
7E00- 1060 DP.LINK .EQ $7E00
7E02- 1070 AMP.LINK .EQ $7E02
1080
BE03- 1090 DOS.COMMAND .EQ $BE03
BEF5- 1100 GET.BUFFER .EQ $BEF5
BEF8- 1110 FREE.BUFFER .EQ $BEF8
1120
FDF0- 1130 COUT1 .EQ $FDF0
1140 #-----
1150 .OR $300
1160 .TF INSTALL.DP18,s3,d2
1170
0300- 1180 T JSR FREE.BUFFER kick others out
0303- A9 1C 1190 LDA #$1C
0305- 20 F5 BE 1200 JSR GET.BUFFER get 28 pages
0308- B0 26 1210 BCS ERROR
030A- C9 7E 1220 CMP #$7E must be at $7E00
030C- D0 22 1230 BNE ERROR
1240
030E- A2 0A 1250 LDX #LENGTH
0310- BD 52 03 1260 .1 LDA COMMAND,X "BLOAD DP18"
0313- 9D 00 02 1270 STA BUFFER,X
0316- CA 1280 DEX
0317- 10 F7 1290 BPL .1
0319- 20 03 BE 1300 JSR DOS.COMMAND do it
031C- B0 12 1310 BCS ERROR
```

```

031E- A2 01      1320
0320- BD F6 03   1330      LDX #1
0323- 9D 02 7E   1340      LDA AMPERSAND,X      save old vector
0326- BD 00 7E   1350      STA AMP.LINK,X
0329- 9D F6 03   1360      LDA DP.LINK,X      & point to DP18
032C- CA        1370      STA AMPERSAND,X
032D- 10 F1      1380      DEX
032F- 60        1390      BPL .2
          1400      EXIT      RTS
          1410
0330- A2 00      1420      ERROR LDX #0
0332- BD 3D 03   1430      LDA MESSAGE,X      show error message
0335- F0 F8      1440      BEQ EXIT
0337- 20 F0 FD   1450      JSR COUT1
033A- E8        1460      INX
033B- D0 F5      1470      BNE .1
          1480      *-----
          1490      MESSAGE .HS 8D

033D- 8D        1500
033E- C5 F2 F2   1510      .AS -/Error loading DP18/
0341- EF F2 A0   1520      .HS 8D00
0344- EC EF E1
0347- E4 E9 EE
034A- E7 A0 C4
034D- D0 B1 B8
0350- 8D 00
0352- C2 CC CF
0355- C1 C4 A0
0358- C4 D0 B1
035B- B8
035C- 8D
0A-

1530      COMMAND .AS -/BLOAD DP18/
1540      .HS 8D
1550      LENGTH  .EQ *-COMMAND-1
1560      *-----

```

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A couple of months ago I presented an RWTS so DOS 3.3 could read and write Apple's new UniDisk 3.5. At that time I promised the additional code so we could boot DOS from the new device. Well, it took a little longer than I had planned, but here are the changes necessary so FORMAT.UNIDISK can produce a bootable disk.

There are two parts to the problem. We must first come up with a way to write a DOS image on the disk during formatting, and we must have a boot sector that can read in the new image and start it up. Since we have 32 sectors in track 0, with 30 of them available for the DOS image, I looked up Bob S-C's article from the April '86 issue on stuffing DOS into fewer sectors for faster booting. In that article he pointed out that we don't need to deal with pages \$B3-B4 and \$BB, since they're used for buffers, and that these days we can assume that all machines have at least 48K of RAM, so we don't need the relocater code from a DOS master. Eliminating these areas shaves the DOS image down to 32 sectors, but I still needed to get rid of two more to avoid carrying the boot code around inside DOS.

One more was easy: page \$BC is just buffer in my RWTS. Then I noticed that nearly all of the code in pages \$B6 and \$B7 is used only by INIT and the boot process, and could therefore be done away with. It turns out that the only necessary part of \$B6 is the various APPEND and VERIFY patches from \$B65D-B6B2. Similarly, the only vital things in page \$B7 are the RWTS entry at \$B7B5-B7C1, a buffer clearing routine at \$B7D6-B7DE, and RWTS's IOB and DCT from \$B7E8-B7FE. I also decided to keep the read/write a group of pages code from \$B793-B7B4, since some programs borrow that routine. So, I came up with some routines to pack the necessary areas in \$B7 into the unused space in \$B6 and thereby save another page.

Since we're booting in from the Protocol Converter, we don't immediately have the ability to read individual sectors. All we can do is read blocks, or pairs of sectors, and the DOS image doesn't conveniently split up into even blocks. Here's how I ended up mapping DOS pages into blocks:

0 - Boot	4 - A3-A4	8 - AB-AC	C - B3,B6
1 - 9D-9E	5 - A5-A6	9 - AD-AE	D - B8-B9
2 - 9F-A0	6 - A7-A8	A - AF-B0	E - BA,BD
3 - A1-A2	7 - A9-AA	B - B1-B2	F - BE-BF

Note that this formatter uses the DOS image in memory. You need to make sure that this DOS contains all of the patches you want to use, and ONLY the patches that can be used from bootup time. For example, I got into trouble when I initialized a disk with a DOS patched to use my memory expansion card as a RAM disk. Those patches depend on some code being in place in page zero of the alternate banks of the memory card, and that code wasn't there at boot time. The answer is to initialize the disk without these patches, and then make BRUN RAMDRIVE part of the HELLO program. You may have to make some such adjustment for your own system.

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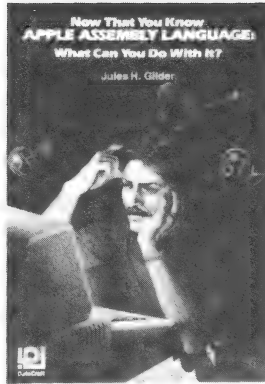
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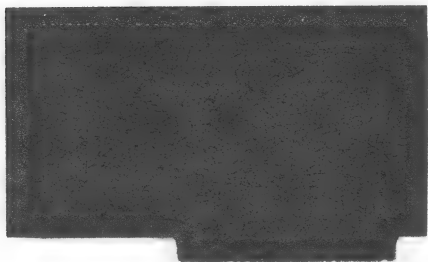
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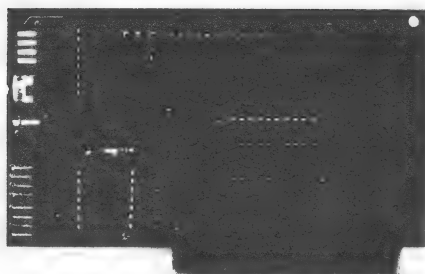
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```

3050 BOOT.IMAGE
3060 .PH $800
3070 .DA #1
0800- 01 3080 BOOT PHA
0801- 48 3090 LDA $58 save slot#16
0802- A5 58 3100 ORA #$C0 get slot
0804- 09 C0 3110 PHA form Cslot
0806- 48 3120 STA .1+2 save it
0807- 8D 0F 08 3130 STA .2+2 fix entry address
080A- 8D 18 08 3140 .1 LDA $FFFF fix call address
080D- AD FF FF 3150 CLC get ProDOS entry
0810- 18 3160 ADC #3
0811- 69 03 3170 STA .2+1 set PC entry
0813- 8D 17 08 3180
0816- 20 FF FF 3190 .2 JSR $FFFF call PC
0819- 01 3200 .DA #1 READ
081A- 9E 08 3210 .DA PARMLIST
081C- EE A1 08 3220 INC PC.BUFFER+1 ready for next block
081F- EE A1 08 3230 INC PC.BUFFER+1
0822- EE A2 08 3240 INC BLOCK next block
0825- AD A2 08 3250 LDA BLOCK
0828- C9 10 3260 CMP #$10 we only want $1-F
082A- 90 EA 3270 BCC .2
3280
3290 RELOCATE.PAGES
082C- A2 00 3300 LDX #0
082E- BD 00 BA 3310 .1 LDA $BA00,X relocate packed pages
0831- 9D 00 BF 3320 STA $BF00,X
0834- BD 00 B9 3330 LDA $B900,X
0837- 9D 00 BE 3340 STA $BE00,X
083A- BD 00 B8 3350 LDA $B800,X
083D- 9D 00 BD 3360 STA $BD00,X
0840- BD 00 B7 3370 LDA $B700,X
0843- 9D 00 BA 3380 STA $BA00,X
0846- BD 00 B6 3390 LDA $B600,X
0849- 9D 00 B9 3400 STA $B900,X
084C- BD 00 B5 3410 LDA $B500,X
084F- 9D 00 B8 3420 STA $B800,X
0852- BD 00 B4 3430 LDA $B400,X
0855- 9D 00 B6 3440 STA $B600,X
0858- E8 3450 INX
0859- D0 D3 3460 BNE .1
3470
085B- BC A5 08 3480 FIX.B7 LDY TABLE.B7,X get segment size
085E- F0 19 3490 BEQ FIX.SLOT.REFS done?
0860- E8 3500 INX
0861- BD A5 08 3510 LDA TABLE.B7,X get $B7 offset
0864- 8D 6B 08 3520 STA .3 into STA
0867- AD 00 B6 3530 .1 LDA $B600
0868- 3540 .2 .EQ #-2
086A- 8D 00 B7 3550 STA $B700
086B- 3560 .3 .EQ #-2
086D- EE 68 08 3570 INC .2 next source
0870- EE 6B 08 3580 INC .3 next destination
0873- 88 3590 DEY
0874- D0 F1 3600 BNE .1 segment done?
0876- E8 3610 INX
0877- D0 E2 3620 BNE FIX.B7 ...always
3630
3640 FIX.SLOT.REFS
0879- 68 3650 PLA get Cslot
087A- 8D 49 BF 3660 STA MY.READ
087D- 8D 6B BF 3670 STA MY.WRITE
0880- 68 3680 PLA get slot#16
0881- 8D E9 B7 3690 STA IOB.SLOT
0884- 8D F7 B7 3700 STA IOB.OSLOT
0887- 8D B0 BE 3710 STA MY.COMPARE
088A- A9 01 3720 LDA #1
088C- 8D EA B7 3730 STA IOB.DRIVE
088F- 8D F8 B7 3740 STA IOB.ODRIVE
0892- A2 FF 3750 LDX #$FF new stack
0894- 9A 3760 TXS
0895- 20 89 FE 3770 JSR SETKBD set I/O hooks
0898- 20 93 FE 3780 JSR SETVID
089B- 4C 84 9D 3790 JMP COLDSTART & go to DOS
3800 *-----

```

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```

08D6- 88      2170      DEY                      done with segment?
08D7- D0 F1    2180      BNE .2
08D9- E8      2190      INX                      next byte in table
08DA- D0 E2    2200      BNE .1                  ...always
                                2210
08DC- A9 0C    2220      .5 LDA /MY.BUFFER      point BUFFER here
08DE- 60      2230      RTS
                                2240
                                2250 B7.TABLE
08DF- 2F 93    2260      .DA ##2F,##B793      R/W group & call RWTS
08E1- 09 D6    2270      .DA ##9,##B7D6       zero a buffer
08E3- 17 E8    2280      .DA ##17,##B7E8      IOB & DCT
08E5- 00      2290      .DA #0
                                2300 *-----
08E6- 8D ED 08 2310      MOVE.PAGE.TO.BUFFER
08E9- A0 00    2320      STA .2              A has either $AA or $B6
08EB- B9 00 FF 2330      LDY #0
08ED-      2340      LDA $FF00,Y
08EE- 99 00 0C 2350      .2 .EQ #-1
08F1- C8      2360      STA MY.BUFFER,Y
08F2- D0 F7    2370      INY
08F4- 60      2380      BNE .1
                                2390      RTS
                                2400 *-----
08F5- 0A 0B    2410      PAGE.TABLE
08F7- 9D 9E 9F 2420      .DA /BOOT.IMAGE,/BOOT.IMAGE+$100
08FA- A0 A1 A2
08FD- A3 A4
08FF- A5 A6 A7 2430      .HS 9D.9E.9F.A0.A1.A2.A3.A4
0902- A8 A9 AA
0905- AB AC    2440      .HS A5.A6.A7.A8.A9.AA.AB.AC
0907- AD AE AF
090A- B0 B1 B2
090D- B3      2450      .HS AD.AE.AF.B0.B1.B2.B3
090E- B6 B8 B9
0911- BA BD BE
0914- BF      2460      .HS B6.B8.B9.BA.BD.BE.BF
                                2470
                                2480 STARTUP.NAME
0915- C8 C5 CC 2490      .AS -/HELLO/
0918- CC CF    2500      .BS STARTUP.NAME+30-*, " "
091A-

```

The main body of DO.DOS.IMAGE just writes the DOS pages listed in PAGE.TABLE onto sectors 0-\$1F of track 0, providing special handling for pages \$AA and \$B6. In page \$AA we must install a startup program name into the filename buffer and then force the last-command-executed index to its INIT value, so the coldstart code will work properly after a boot. Page \$B6 is a little more involved. We need to move certain segments from page \$B7 in with \$B6, using a table containing the lengths and addresses of the segments.

And the last step is installing some real boot code in place of the dummy message. Just delete lines 2200-2390 of the old program and put in the rest of the new code:

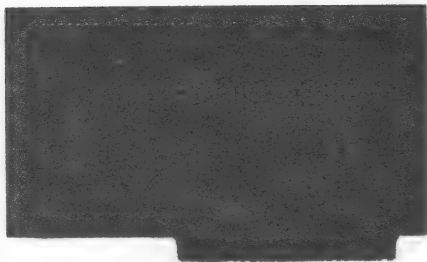
```

0971-      2920      .BS *+255/256*256-*
                                2930
09D84-      2940 COLDSTART .EQ $9D84
07E9-      2950 IOB.SLOT .EQ $B7E9
07EA-      2960 IOB.DRIVE .EQ $B7EA
07F7-      2970 IOB.OSLOT .EQ $B7F7
07F8-      2980 IOB.ODRIVE .EQ $B7F8
0EB0-      2990 MY.COMPARE .EQ $BEB0
0F49-      3000 MY.READ .EQ $BF49
0F6B-      3010 MY.WRITE .EQ $BF6B
0E89-      3020 SETKBD .EQ $FE89
0E93-      3030 SETVID .EQ $FE93
                                3040 *-----

```

} inside RWTS.3.5

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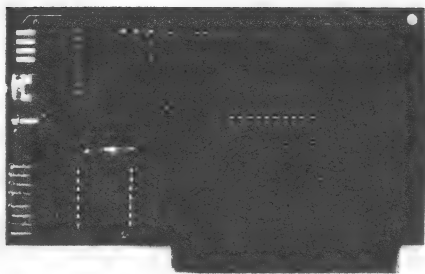
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```

3050 BOOT.IMAGE
3060 .PH $800
3070 .DA #1
0800- 01 3080 BOOT PHA save slot*16
0801- 48 3090 LDA $58 get slot
0802- A5 58 3100 ORA #$C0 form Cslot
0804- 09 C0 3110 PHA save it
0806- 48 3120 STA .1+2 fix entry address
0807- 8D 0F 08 3130 STA .2+2 fix call address
080A- 8D 18 08 3140 .1 LDA $FFFF get ProDOS entry
080D- AD FF FF 3150 CLC
0810- 18 3160 ADC #3
0811- 69 03 3170 STA .2+1 set PC entry
0813- 8D 17 08 3180
3190 .2 JSR $FFFF call PC
0816- 20 FF FF 3200 .DA #1 READ
0819- 01 3210 .DA FARMLIST
081A- 9E 08 3220 INC PC.BUFFER+1 ready for next block
081C- EE A1 08 3230 INC PC.BUFFER+1
081F- EE A1 08 3240 INC BLOCK next block
0822- EE A2 08 3250 LDA BLOCK
0825- AD A2 08 3260 CMP #$10 we only want $1-F
0828- C9 10 3270 BCC .2
082A- 90 EA 3280
3290 RELOCATE.PAGES
082C- A2 00 3300 LDX #0
082E- BD 00 BA 3310 .1 LDA $BA00,X relocate packed pages
0831- 9D 00 BF 3320 STA $BF00,X
0834- BD 00 B9 3330 LDA $B900,X
0837- 9D 00 BE 3340 STA $BE00,X
083A- BD 00 B8 3350 LDA $B800,X
083D- 9D 00 BD 3360 STA $BD00,X
0840- BD 00 B7 3370 LDA $B700,X
0843- 9D 00 BA 3380 STA $BA00,X
0846- BD 00 B6 3390 LDA $B600,X
0849- 9D 00 B9 3400 STA $B900,X
084C- BD 00 B5 3410 LDA $B500,X
084F- 9D 00 B8 3420 STA $B800,X
0852- BD 00 B4 3430 LDA $B400,X
0855- 9D 00 B6 3440 STA $B600,X
0858- E8 3450 INX
0859- D0 D3 3460 BNE .1
3470
085B- BC A5 08 3480 FIX.B7 LDY TABLE.B7,X get segment size
085E- F0 19 3490 BEQ FIX.SLOT.REFS done?
0860- E8 3500 INX
0861- BD A5 08 3510 LDA TABLE.B7,X get $B7 offset
0864- 8D 6B 08 3520 STA .3 into STA
0867- AD 00 B6 3530 .1 LDA $B600
0868- 3540 .2 .EQ #-2
086A- 8D 00 B7 3550 STA $B700
086B- 3560 .3 .EQ #-2
086D- EE 68 08 3570 INC .2 next source
0870- EE 6B 08 3580 INC .3 next destination
0873- 88 3590 DEY
0874- D0 F1 3600 BNE .1 segment done?
0876- E8 3610 INX
0877- D0 E2 3620 BNE FIX.B7 ...always
3630
3640 FIX.SLOT.REFS
0879- 68 3650 PLA get Cslot
087A- 8D 49 BF 3660 STA MY.READ
087D- 8D 6B BF 3670 STA MY.WRITE
0880- 68 3680 PLA get slot*16
0881- 8D E9 B7 3690 STA IOB.SLOT
0884- 8D F7 B7 3700 STA IOB.OSLOT
0887- 8D B0 BE 3710 STA MY.COMPARE
088A- A9 01 3720 LDA #1
088C- 8D EA B7 3730 STA IOB.DRIVE
088F- 8D FB B7 3740 STA IOB.ODRIVE
0892- A2 FF 3750 LDX $FFF new stack
0894- 9A 3760 TXS
0895- 20 89 FE 3770 JSR SETKBD set I/O hooks
0898- 20 93 FE 3780 JSR SETVID
089B- 4C 84 9D 3790 JMP COLDSTART & go to DOS
3800 *-----

```

```

089E- 03      3810 PARMLIST .DA #3
089F- 01      3820 .DA #1
08A0- 00 9D   3830 PC.BUFFER .DA $9D00
08A2- 01 00 00 3840 BLOCK .DA <1
                3850
08A5- 2F 93   3860 TABLE.B7 .DA ##2F,##B793
08A7- 09 D6   3870 .DA ##9,##B7D6
08A9- 17 E8   3880 .DA ##17,##B7E8
08AB- 00      3890 .DA #0
                3900
                3910 .EP
AC-           3920 BOOT.SIZE .EQ *-BOOT.IMAGE
                3930 *-----*
OAC-         3940 .BS BOOT.IMAGE+$200-*
                3950 MY.BUFFER

```

Here we take note of which slot we're booting from and set up the Protocol Converter calls to read blocks 1-F into memory starting at \$9D00. Then we move the last seven pages up to their real locations and unpack the \$B7 information from page \$B6. The last step is to plug the current slot and drive info into the IOB, so DOS will know where to look for the HELLO program, and the correct slot location into MY.READ, MY.WRITE and MY.COMPARE. Note that these addresses are inside RWTS 3.5 and may change if you modify that program.

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How Many Cycles Does "BRL" Take?.....Bob Sander-Cederlof

There seems to be some disagreement among the various references for the 65802/16 chip as to how many cycles some of the opcodes take. One in particular that is wrong in almost all places is the BRL (Branch Long) opcode.

BRL is an unconditional branch, just like BRA. Neither opcode is found in the 6502. BRA (Branch Always) is found in both the 65C02 and the 65802/16 chips. BRL is only in the 65802/16. BRA takes a single-byte relative offset, just like the conditional branch instructions; therefore, BRA can only branch within -127 to +128 bytes from the instruction. BRL takes a two-byte relative offset, so it can branch anywhere within the 64K bank of memory containing the instruction.

Most references, including the data sheets from Western Design Center and GTE, say that the BRL opcode takes 3 cycles. One reference even went so far as to claim the JMP opcode was obsolete, because BRL and JMP both took 3 cycles and 3 bytes, and BRL had the advantage of being a "run-anywhere" instruction.

However, David Eyes claims in his book that BRL takes 4 cycles.

Naturally, the final authority is the chip itself. But how do you measure the timing of one little instruction? One way is to use a logic analyzer (a very expensive piece of hardware that can give a cycle-by-cycle description of whatever electronic circuit it is attached to). Another is to write a program that will run a loop millions or billions of times, and time it with a stopwatch. The loop first has to be timed without the opcode you are examining, and later with the opcode; then you subtract and divide to get the number of cycles the opcode took.

I thought of a simpler way. I just use my ears! I wrote a loop that toggled the speaker, and put a known 3-cycle opcode inside the loop. Then I duplicated the loop using a BRL instruction in place of the known 3-cycle opcode. When the program runs, the first loop makes a certain tone until I press a key. Then control passes to the second loop. If the second loop makes the same tone, then BRL also takes 3 cycles. If the second tone is higher, BRL takes less than 3 cycles; if lower, then more than 3 cycles. Here is the program:

```
1000 *SAVE S.TEST.BRL.TIMING
      1010 .OP 65802
      1020 *-----
      1030 TEST.BRL.TIMING
000800- AD 30 C0 1040 .1 LDA $C030 PLAY A TONE
000803- AO 80 1050 LDY #128
000805- 88 1060 .2 DEY
000806- 4C 09 08 1070 JMP .3 KNOWN TO BE 3 CYCLES
000809- DO FA 1080 .3 BNE .2
00080B- AD 00 C0 1090 LDA $C000 REPEAT TONE UNTIL KEYPRESS
00080E- 10 F0 1100 BPL .1
000810- 8D 10 C0 1110 STA $C010
```

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```

000813- AD 30 C0    1120 *---NOW MAKE TONE WITH "BRL"---
000816- A0 80      1130 .4    LDA $C030
000818- 88         1140     LDY #128
000819- 82 00 00   1150 .5    DEY
00081C- D0 FA      1160     BRL .6        IF 4 CYCLES, LOWER PITCH TONE
00081E- AD 00 C0   1170 .6    BNE .5
000821- 10 F0      1180     LDA $C000    REPEAT TONE UNTIL KEYPRESS
000823- 8D 10 C0   1190     BPL .4
000826- 60         1200     STA $C010
                   1210     RTS
                   1220 *-----

```

The known 3-cycle instruction is the JMP at line 1070. The BRL is inside the second loop at line 1160. When I ran the program, it produced a lower pitch for the BRL-loop. So, BRL takes more than 3 cycles. Is it 4 cycles?

I replaced line 1070 with two NOP lines, which takes 4 cycles altogether. Then I ran the program again, and both loops made the same pitch. Voila! BRL does take 4 cycles. Just to be sure, I made some more tests. They all told the same story.

Then I noticed that the references also disagree on the BRA opcode. Most say it takes 2 cycles. Since the other relative branches only take 2 cycles when they DON'T branch, and BRA never does that, something had to be wrong. In a 6502, 65C02, or 65802/16 Emulation mode, other relative branches take 3 cycles to branch when the target is in the same page as the next byte after the instruction itself, and 4 cycles when the target is in a different page. In 65802/16 Native mode, the conditional relative branches never take more than 3 cycles.

I modified my program to set up page-boundary crossings in various combinations and tested the BRA opcode. It always takes 3 cycles in Native mode. In Emulation mode or older chips it takes 3 or 4 cycles, just like the conditional branches.

If you wonder about the timing of other opcodes, you can set up similar tests.

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